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FILAMENT NUMBER	B DEGREES	$\frac{bR}{e}$ VOLTS	ϕ VOLTS
1	27,200	2.34	2.39
2	30,100	2.59	2.54
3	23,500	2.02	1.97
4	25,200	2.16	2.28
5	38,200	3.28	3.22
6	40,600	3.49	3.45

Filaments 1 and 2 were coated with BaO 50%, SrO 25%, CaO 25%, Filaments 3 and 4 with BaO 50%, SrO 50%, and Filaments 5 and 6 with CaO alone.

It appears that for Wehnelt cathodes the values ϕ and bR/e show a good correspondence. This is a strong point in favor of the view that the emission of electrons from Wehnelt cathodes is due to a similar mechanism to that causing the emission from heated pure metals. It is also a further proof of the substantial correctness of Richardson's hypotheses to account for the emission of electrons by hot bodies.

DAILY VARIATION OF WATER AND DRY MATTER IN THE LEAVES OF CORN AND THE SORGHUMS

By Edwin C. Miller

KANSAS AGRICULTURAL EXPERIMENT STATION

Communicated by R. Pearl, May 14, 1917

In connection with the study of the water relations of corn and the non-saccharine sorghums previously reported by me (*J. Agric. Res.*, **6**, 1916), it was thought advisable to determine the daily variation of the water and dry matter in the leaves of these plants. A knowledge of the variation of the water in the leaves should throw some light on the relative ability of these plants to absorb water from the soil and to transport it to regions of loss from transpiration, while a study of the daily variation of dry matter in the leaves would permit a comparison of the relative power of the plants to manufacture food under different climatic conditions. The experiments herein reported were conducted during the summers of 1914, 1915, and 1916 at the State Branch Experiment Station at Garden City, Kans.

Cultural Methods.—The plants used in these experiments were Pride of Saline corn, Blackhull kafir and Dwarf milo. In 1914 and 1915, the plants were grown in alternate rows on the same plot, while in 1916 the experiments were made with plants grown on a series of one twentieth acre plots. The plants were grown in a sandy loam soil that had been fall plowed and irrigated with approximately 8 inches of water. The crops were surface planted in rows 44 inches apart. After the plants were a few inches high the corn was thinned to a distance of 2 feet between the plants, Blackhull kafir to 1½ feet and the Dwarf milo to 1 foot. The plots were scraped with a hoe to keep the weeds down but no other cultivation was given during the growing season. The plots received no water after the fall irrigation, except that which came from the rainfall.

Leaf Sampling.—The amount of water and dry matter in the leaves of a given variety of plant was determined every two hours from 30 leaf samples, each with an area of 1 sq. cm. Thirty representative plants of each variety were selected and a leaf chosen on each plant for furnishing all the samples for an experiment extending over the desired length of time. At 7 a.m. a single sample was taken from each of the 30 selected leaves toward their tips. This was done by means of a Ganong leaf punch with an area of one square centimeter. At 9 a.m. a sample was taken from each of the 30 leaves directly opposite the sample taken at 7 a.m. At 11 a.m. the samples were collected from the leaves directly below those taken at 7 a.m. and then at the next two hour period directly opposite these and so on. The samples for a forty-hour experiment were thus obtained from a portion of the leaves representing less than 6 inches of their respective lengths. The leaf samples from corn, kafir and milo at any period could be collected in the manner described in from five to eight minutes. Care was taken in the selection of the leaves, so that they would be as nearly the same age as possible for the three plants. The uppermost, fully-developed leaf of each plant was the one from which the leaf samples were obtained.

The samples were collected in weighed vials which were then quickly stoppered. The vials containing the moist material were weighed at once on balances sensitive to one tenth milligram. They were then placed in a drying oven at 100–105°C. until all the moisture was driven off. After drying, the samples were cooled in a desiccator over sulphuric acid and weighed so that the amount of water and dry matter could be obtained.

Results.—Nine experiments were conducted in 1914, two in 1915 and four in 1916. Four of the experiments in 1914 extended only through the daylight hours but all of the other experiments ranged in length from twenty-four to forty hours. In all the amount of water and dry matter in the leaves was determined every two hours for twenty-two days and ten nights. The amount of water in the leaves at any period of the night could be accurately determined owing to the fact that dew is very rare during the summer in this portion of the Great Plains. Corn, kafir, and milo were used in all the experiments with but two exceptions in 1916. In these two experiments only corn and milo were used. The amount of water in the leaves was determined in grams per square meter of leaf; percentage on a wet basis and dry basis for each two hour period of the experiment. The amount of dry matter was determined in grams per square meter of leaf and in percentage of the moist weight of the leaf.

The leaves of milo contained less water at all times than the leaves of either corn or kafir at the same stage of development. The average water content per square meter of leaf for all the observations made was 111.4 grams for milo, 123.2 grams for corn and 126.3 grams for kafir. The amount of water in the leaves of corn and kafir was practically the same at like stages of growth. The small difference between the average amount of water in the leaves of kafir as compared with those of corn, is due to the fact that in one experiment in 1914 and in two experiments in 1916, the leaves of the kafir were about ten days younger than those of the corn and, as a consequence, contained a greater amount of water.

Under the conditions of these experiments, the leaves of corn in most cases were wilted during the greater portion of the day. The first signs of wilting were most generally observed between 9 a.m. and 10 a.m. and in most cases no visible wilting could be observed after 4 p.m. The kafir leaves wilted during the day, but not to the extent that the leaves of the corn did while the milo leaves showed little or no signs of wilting. Under these conditions the average range between the maximum and minimum amount of water per square meter of leaf during the two hour periods from 7 a.m. to 7 p.m. was 13.8 grams for corn, 8.4 grams for kafir and 7.8 grams for milo.

Table 1 shows the average gain or loss of leaf water during each two hour period of the day from 7 a.m. to 5 p.m. for the experiments conducted in 1914, 1915 and 1916. The average gain or loss for each period is expressed in grams per square meter of leaf and in percentage based on the water in the leaf at the beginning of the two hour period.

A consideration of the loss of the leaf water during the day shows that from 7 a.m. to 9 a.m. the rate of loss was practically the same for corn and milo and the least for kafir. From 9 a.m. to 11 a.m. as the aerial conditions became more severe, the rate of loss increased for corn and kafir, but decreased almost one half for milo. During the next two hours the rate of loss decreased for all three plants, but the rate of loss was approximately twice as great for corn and kafir as for milo. From 1 p.m. to 3 p.m. the rate of loss continued to decrease, while the rate of loss of

TABLE I

SUMMARY OF THE VARIATION OF THE WATER CONTENT OF THE LEAVES OF CORN KAFIR AND MILO DURING THE YEARS 1914, 1915 AND 1916 AT GARDEN CITY, KANSAS

TIME	PLANTS	LOSS			GAIN			NET GAIN OR LOSS	
		Number of cases of loss	Average loss of leaf water per square meter of leaf	Average per cent of loss based on leaf water at beginning of period	Number of cases of gain	Average gain of leaf water per square meter of leaf	Average per cent of loss based on leaf water at beginning of period	Per square meter of leaf	Per cent based on leaf water at beginning of period
			grams			*grams*		*grams*	
7 a.m.– 9 a.m.	Corn	21	4.1	3.5	0	0	0	4.1 loss	3.5 loss
	Kafir	15	3.3	2.8	1	3.8	3.2	3.0 loss	2.5 loss
	Milo	18	4.2	4.0	3	1.3	1.3	3.6 loss	3.4 loss
9 a.m.–11 a.m.	Corn	18	4.8	4.2	2	2.5	2.2	4.1 loss	3.8 loss
	Kafir	16	3.9	3.4	1	1.3	1.0	3.7 loss	3.4 loss
	Milo	20	2.2	2.1	1	5.2	5.6	1.9 loss	1.8 loss
11 a.m.– 1 p.m.	Corn	15	3.7	3.4	6	2.9	2.4	2.5 loss	2.2 loss
	Kafir	14	3.1	2.8	3	4.2	3.6	2.5 loss	2.2 loss
	Milo	13	1.9	1.9	7	1.7	1.6	1.1 loss	1.1 loss
1 p.m.– 3 p.m.	Corn	10	3.1	2.8	10	2.5	2.2	1.8 loss	1.6 loss
	Kafir	4	2.5	2.1	13	3.1	2.7	2.0 gain	1.7 gain
	Milo	11	3.3	3.3	10	2.6	2.5	1.7 loss	1.6 loss
3 p.m.– 5 p.m.	Corn	4	2.7	2.3	17	5.7	4.9	4.6 gain	4.0 gain
	Kafir	0	0	0	17	4.3	3.6	4.3 gain	3.6 gain
	Milo	4	4.1	4.2	17	3.9	3.7	3.2 gain	3.0 gain

milo increased over one per cent. These results seem to indicate that the absorption of water by the milo from the soil and its translocation to leaves, was proceeding more rapidly in proportion to the loss of water from the plant than in the case of either corn or kafir. The fact that the leaves of milo seldom wilted during the day also indicated that fact. The wilting of the leaves of milo in contrast to either the corn or kafir usually could not be observed until much later in the day. The increase in the rate of loss of leaf water in the milo from 1 p.m. to 3 p.m. would indicate, that the rate of absorption of water from the soil during that period, was less than the loss by evaporation from the leaves.

The amount of dry matter in the leaves of milo was at all times greater than in the leaves of corn or kafir of the same age. Taking the average weight of a square meter of corn leaf as 1, the average weight of an equal area of leaf would be 1.08 for kafir and 1.16 for milo. These differences in weight could be due either to the more compact arrangement of the cells, or to a difference in the thickness of the leaves of the three plants or to both of these factors.

The average difference between the maximum and minimum amount of dry matter in the leaves during the day from 7 a.m. to 7 p.m. was 4 grams for corn, 4.8 grams for kafir and 8.0 grams for milo. Table 2 shows the rate of increase in dry matter for corn, kafir and milo in grams per square meter of leaf for each of the two hour periods during the day, from 7 a.m. to 5 p.m.

TABLE II

AVERAGE RATE OF INCREASE OF THE DRY MATTER FOR EACH SQUARE METER OF LEAF FOR CORN, KAFIR AND MILO DURING EACH TWO HOUR PERIOD OF THE DAY

PLANT	A. M.			P. M.	
	7–9	9–11	11–1	1–3	3–5
	grams	*grams*	*grams*	*grams*	*gram*
Corn	2.2	1.1	0.8	0.7	0.8
Kafir	1.7	1.2	0.7	1.2	0.7
Milo	1.3	1.5	2.2	2.0	0.8

Two explanations are possible for these results. The milo plant either manufactures food in the leaves more rapidly than the corn or kafir, or the rate of translocation is higher in the latter plants. In most cases, under the conditions of these experiments, the leaves of corn were badly wilted during the greater portion of the day. The kafir leaves also wilted but not to the extent of the corn, while the leaves of milo very seldom showed signs of wilting. The smaller increase in dry matter in the leaves of corn and kafir during the greater portion of the day in comparison to the leaves of milo is evidently due to the severe climatic conditions. The high evaporation of water from the leaves of corn and kafir exceeds the intake by the roots and as a consequence, the water content is lowered to such an extent as to interfere with the vital processes of the protoplasm. The rise in temperature of the leaves due to the decreased transpiration may also be a factor in lowering the photosynthetic power of these plants.

The results indicate that under the conditions of these experiments, the sorghums and more particularly milo, can absorb water from the soil and transport it to the leaves more rapidly in proportion to the loss of water from the plant than can corn. As a result of this ability the sorghums can produce more dry matter for each unit of leaf area under severe climatic conditions than can the corn plant.

Further details are given in the *Journal of Agricultural Research*, 1917.